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EFFECT OF DRAG-REDUCING POLYMER INJECTION ON THE LIFT AND DRAG OF A TWO-DIMENSIONAL HYDROFOIL

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Project TRANSIM

A Ten-Year Progress Report

School of Engineering and Applied Science
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The present paper describes an experimental investigation on the effects of injecting drag-reducing polymer solutions into the turbulent boundary layer of two NACA 63, two-dimensional, symmetrical, hydrofoils. The experiments were performed in a high-speed circulating channel with free stream velocities of up to 13 m/sec. The two foils used were 10 and 20 cm in chord, though

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and expanding its application in an increasing number of Navy management problem areas. Specific coverage is given to application to:

Marine Port Systems
Amphibious Operations
Shipyard Operations
Ship Systems
Integrated Logistics Support
Naval Supplies Distribution
Ship Acquisition Project Management
Ship Repair/Modernization/Overhaul
Planning Project Management
Naval Facilities Project Management

ABSTRACT

This report discusses the significant accomplishments of Project TRANSIM at the University of California, Los Angeles, under ONR Contract N00014-69-A-0200-4009, during the ten-year period ending December 31, 1973. The research and development program is an extension and expansion of earlier work at UCLA and concentrated on further development of general-purpose computer simulation as a versatile and effective analytical tool and expanding its application in an increasing number of Navy management problem areas. Specific coverage is given to application to:

Marine Port Systems

Amphibious Operations

Shipyard Operations

Ship Systems

Integrated Logistics Support

Naval Supplies Distribution

Ship Acquisition Project Management

Ship Repair/Modernization/Overhaul
Planning Project Management

Naval Facilities Project Management

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I. INTRODUCTION

This is the final report for ONR Contract N00014-69-A-0200-4009 which began on September 1, 1963 and ended December 31, 1973. The Research Program under the contract was an extension and expansion of earlier work (beginning in 1951) accomplished at UCLA under Office of Naval Research sponsorship on the general subject of Maritime cargo handling. During the ten-year period 1963-73 there were 31 individual tasks and extensions to the Research contract, with major funding support furnished by the Naval Ship System Command (NAVSHIPS).

Under the previous contract, a considerable number of the studies (References 1 through 24) had analyzed individual segments of port terminal cargo handling operations. In order to include a sufficient number of interfacing port system elements and interactions, including those with the surrounding urban complex of rail and highway networks, the initial task of the current program was to develop a general simulation model[24] that would allow a wide range of commodity shipments, ship types, inland transport modes, transfer equipment, processes and management systems. The generalized model was suitable for specific ports and was designed to identify those systems imbalances which would produce congestion resulting in lower productivity and higher costs. The general model also had the capability for use in evaluation of improvements in techniques, methods, equipment and systems.

As the research progressed, however, the emphasis was shifted from development of a general model to development of a generalized modeling process[26] in response to the experience gained on a wide range of applications to various port projects.

Subsequently the capabilities of the generalized modeling techniques were extended to universal coverage of all system situations describable in terms of flow processes. Included are diverse applications such as:

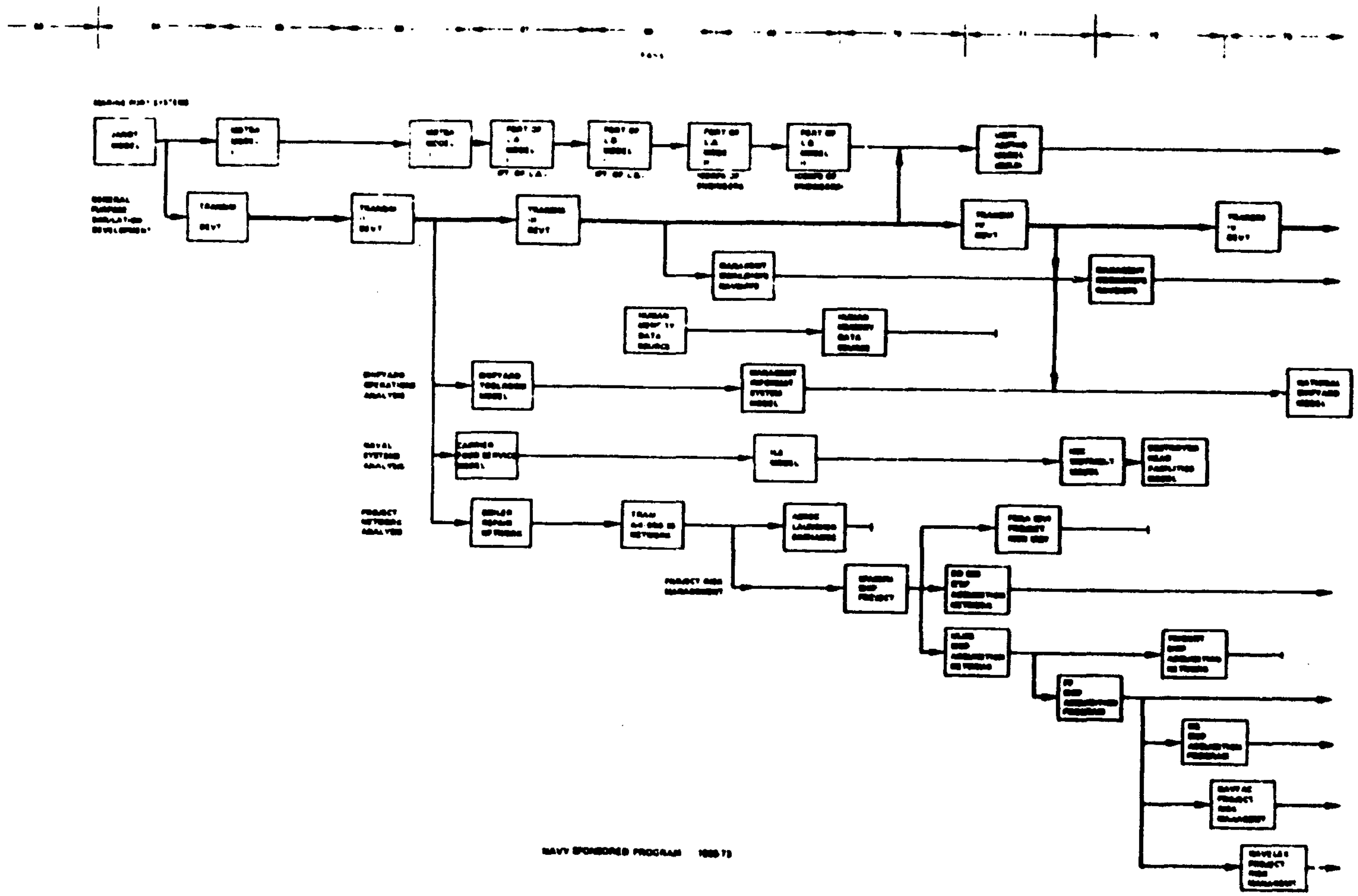

Figure 1   Navy Sponsored Program 1963/73

Marine Port Systems[28, 29, 32]

Project Network Analysis[27, 31, 34, 36]

Management Information System[33]

Integrated Logistics Support[35]

Amphibious System Operation[39]

Shipboard Systems[40]

Project Risk Management[41]

Shipyard Operations

These developments are diagrammed in Figure 1 and described in this report under the major section headings.

A significant milestone in the research project is represented by the application of the computer simulator to probabilistic network analysis and the subsequent emphasis of the total project management environment for decision-making based on the analytical results. Incorporated under the Project Risk Management concept, in addition to probabilistic network analysis, are organization, training, information flow, and management reports, all designed to assist in the decision process.

This report covers the significant accomplishments of the ten-year project. The discussion is presented in summary form and reference is made to the specific publications. The subject coverage follows the general project alignment depicted in Figure 1.

II. RESEARCH AND DEVELOPMENT OBJECTIVES

In general, any decision-making process involves a problem to be solved, a number of possibly conflicting objectives to be reconciled, a number of possible alternative courses of action from which the "best" has to be chosen, and some way of measuring the value or payoff of alternative courses of action.

In most real situations, decision-making is conducted under conditions of uncertainty or risk. Under such conditions, the concept of chance or probability plays a central role in decision-making. Monte Carlo simulation procedures, utilizing high-speed, modern digital computers, have proven to be useful in assisting the decision-maker in complex probabilistic problem situations.

The overall objectives of UCLA Project TRANSIM include a long-range research and development program to advance the state of art of computer simulation, in terms of its general-purposeability, simplicity, ease of use, and analytical power and efficiency.

TRANSIM is the acronym applied to the general-purpose simulator developed at UCLA under sponsorship of several government agencies, including the U.S. Departments of Commerce, Defense, and Transportation. The first prototype version, TRANSIM I (1966), is documented and available[42] from the Federal Clearinghouse for Scientific and Technical Information, Springfield, Virginia. Later designations, including TRANSIM II, III, and IV, refer not to unique "packages," but to successive major milestone developments resulting from the continuous research and development program at UCLA in the field of advanced computer simulation. TRANSIM II marked the incorporation of all TRANSIM I input-output features into a single computer program. TRANSIM III converted the basic TRANSIM program from an IBM 7094-only version to a program which could be adapted to many other machines. The TRANSIM IV eliminated all

fixed-format requirements of the input data. The TRANSIM III and IV versions were developed largely under combined sponsorship of the Office of Naval Research and Naval Ship Systems Command.

The Project TRANSIM research and development program has directly benefitted from parallel applications of the simulation technique to actual problem situations occurring within the sponsoring agencies. Feedback from such experiences have been invaluable in aiding the formulation of development end product objectives. Over the ten-year program period reported herein, approximately 50 percent of the project work involved basic research and development tasks, while the remainder of the work was on applications projects connected with testing the developments and obtaining experience feedback for further development guidance purposes.

Human Memory Data Source

Developments in computer simulation and in project management techniques have substantially increased demands for more accurate estimates of activity performance time data. Because of the relatively high cost of obtaining such time data from time-study measurements and the scarcity of data bank sources, the UCLA project investigated techniques for obtaining task duration data from subjective judgment sources. A method was developed[37] which is simple and effective and capable of being utilized in typical data collection situations. It consists of a standard questioning procedure which elicits from the subject a range of estimated activity durations and the probability that each duration estimate will occur.

III. MARINE PORT SYSTEMS

a. Joint Army-Navy Ocean Terminal (JANOT), Oakland

The early development work on the general-purpose computer simulator, TRANSIM I, was benefitted by application to problem situations at the joint Army-Navy Ocean Terminal (JANOT), Oakland, California, through cooperation with the Navy Transportation Management School, NSC, Oakland, California.

During this period of direct application, experiences were gained in the areas of modeling marine port activities, data collection, simulation model validation, and input and output data formats.

In addition to UCLA project involvement, students at the Transportation Management School were given various assignments in the above subject areas as part of their regular classwork and also made significant contributions to the project's development of the computer simulation technique.

b. Military Ocean Terminal, Bay Area (MOTBA), Oakland

An initial major effort under the subject contract was concerned with developing a simulation model of the Military Ocean Terminal, Bay Area (MOTBA), Oakland, California. The model was based on use of the general-purpose modeling technique, TRANSIM I, developed under earlier contracts with the U.S. Department of Commerce.

The specific problem situation analyzed with the MOTBA Model related to the embarkation of an Army Infantry Road Division. The objective was to determine logistic bottlenecks, congestion, and inefficient utilization of JANOT facilities which may contribute to both the degradation of port throughput performance and high costs.

The result of the simulation analysis[26] demonstrated the suitability of the simulation approach for the analysis of complex port problems. In

particular, detailed port problem areas were identified, and specific recommendations pointed to increased efficiency, to the extent of reducing the embarkation time for the Road Division by 25 percent.

The successful problem-solving effort led to a broader analysis of MOTBA operations, in general. The MOTBA simulation model was enlarged in detail to represent inland access modes, including truck and rail, cargo handling, yard and shed storage, and ship loading operations within the MOTBA port-complex. A series of simulation runs were devised to analyze MOTBA operations and to determine the best MOTBA systems designs capable of efficiently handling a wide range of cargo throughput volumes.

The results of the analysis were reported in Reference 28, in which overall MOTBA performance is evaluated in terms of throughput time and direct operating costs. Recommendations for improved performance are included.

c. Port Models

As a direct consequence of the earlier JANOT and MOTBA investigations, the UCLA project undertook the development of computer simulation models of the Ports of Los Angeles and Long Beach, California. The sponsoring agency, the U.S. Corps of Engineers, required the models as the means of evaluation of port development plans presented from time to time by the respective ports.

The port models were initially used to dètermine physical capacities of the ports over a wide range of tonnage volumes. The result of the simulation analysis[36,37] graphically illustrated the influence of berth group operations on overall port capacity. Each berth group, consisting of one or more ship positions operated by, or in behalf of a single management, is in effect a "sub-port." Sub-port capacities are influenced by ship schedules, cargo mix, berth turnaround time, and other factors.

The results are significant in view of past attempts to view and analyze the typical marine port as a "system." In the case of ports containing privately operated berth groups, it is more precise to consider the port-operated inland access modes (rain and truck) on a systems basis and interfacing with the privately operated subsystems, each under different management and control.

d. USMC Amphibious Operations (SMLS)

The Seaborne Mobile Logistics System (SMLS) in an evolving concept of how to provide complete logistic support for amphibious operations from a sea base. One element of the SMLS project was to develop a computer simulation model for systems analysis and evaluation of all aspects of the operations. The TRANSIM simulator was selected as the most suitable approach.

The UCLA project conducted a series of training workshops to familiarize SMLS project personnel with the TRANSIM technique and to assist in the development of the SMLS model.

The SMLS is concerned primarily with the following areas of system operations:

Communication
Medical
Supply
Maintenance
Transportation
Services
Embarkation

Model development is reported in Reference 38; results obtained by the SMLS project group are classified.

IV. ANALYSIS OF SHIPYARD OPERATIONS

a. Shipyard Toolroom Location

The versatility of TRANSIM was demonstrated by a series of applications to a wide variety of problems in fields other than transportation. The first was related to the shipyard environment.

A common problem in the construction of large aircraft carriers is the issuance of special tools to the workman. Conventionally, the workman requiring a special tool or material must walk from his work area to the dockside toolroom. If in stock, the tool is requisitioned and he returns directly to his worksite; however, if out of stock, or not carried in stock, the worker walks to a centrally located toolroom to fill the requisition.

A simulation model of the worker tool procurement process was developed, in order to determine whether any material reduction of walking time would be saved by placing auxiliary toolrooms on board the ship near the worksites.

The results[27] indicated that approximately 50 percent of worker non-productive time seeking special tools can be eliminated by locating auxiliary toolrooms at certain locations on board the carrier. The total savings amounted to 356 manhours per shift.

b. Management Information System

Application of general-purpose computer simulation to problems of information handling and data processing systems was facilitated by a Project TRANSIM effort at Long Beach Naval Shipyard. A model was constructed to represent the existing computer installation at the Yard operating under a workload comprising the Yard's Management Information System (MIS).

The model was designed to allow analysis of utilization of the existing computer equipment and to test the cost-effectiveness of:

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1. Existing MIS workload applied to modified or other computer system configurations.

2. Modified MIS workload in combination with computer system modifications.

Results presented in Reference 30 indicate that significant limitations an existing hardware capacity can be alleviated by a rescheduling of existing data processing workload.

c. National Shipyard Model

In 1973, the U.S. Maritime Administration selected the UCLA project to develop a simulation model of the national shipbuilding and repair capability (ONR is responsible for contract administration). The purpose of the model is to function as a policy and planning tool for:

1. Studing the ramifications of the concept of "national shipyard capacity."

2. Estimation or measuring national shipyard physical capacity and utilization, taking into account current backlog of work and future shipwork projects.

3. Coordination of Navy and Maritime ship programs.

4. Determination of the adequacy of the national ship-building and repair capability in support of mobilization for national defense or emergency.

The National Shipyard Model will cover 32 major private yards and 9 naval shipyards.

V. NAVAL SYSTEMS ANALYSIS

a. Carrier Food Services

An analysis of CVA-class carrier food service operations was conducted for the U.S. Naval Supply Research and Development Facility, Bayonee, New New Jersey. A computer simulation model of carrier food services was developed to determine the relationships between ship complement and galley requirements under various operative circumstances.

The model facilitated investigation of the following operating variables:

Number and rates of arrival of crew members at galley
Food service station staffing levels and service rates
Galley operating schedule
Arrangement of the individual food service stations
in terms of location and layout
Availability of seating in the mess area
Flow of replenishment items and information

The results demonstrated that by rearrangement of food service stations, elimination of congestion points and under utilization of serving facilities, and elimination of replenishment downtimes, an overall system performance can be increased from an existing serving rate of 10 men/min. to approximately 20 men/min.

b. Integrated Logistics Support (ILS)

The UCLA project conducted a study to investigate the feasibility of applying the TRANSIM IV general-purpose simulator to the solution of ILS system problems.

A generalized ILS system model was developed[32] to provide for the solution of a wide variety of ILS problems covering different equipments, subsystems, systems, and entire ships. Not all of the model's components are necessary to analyze any one specific problem situation but were included in order to facilitate "integrated" systems analysis.

The ILS system model covers system operating areas including:

1. On-board resources:

    a. Maintenance personnel - by number and skill

    b. Repair parts inventory

    c. Maintenance equipment and facilities - by type and number

    d. Maintenance documentation

2. On-board or off-site repair actions on defective failed parts

3. Replenishment modes (air delivery, underway replenishment, tender, or in-port)

4. Ashore support facilities: supply stock points, naval shore stations, contractors, etc.

A demonstration application of the ILS model was conducted in connection with maintenance support of the AN-SQS-26-CX sonar system. The example problem is concerned with determining the effects on the sonar system operational availability of specified limitations in maintenance resources. Tabulated results cover the effects of different resource constraints.

c. Destroyer Head Facilities

The Navy's desire to reduce the amount of sanitary wastes being discharged into the sea can be satisfied by two basic methods:

1. Complete shipboard waste treatment systems

2. Providing storage tanks for holding wastes until the ship can discharge the wastes at a shore-based receiving facility

In order to determine the feasibility of converting some of the shipboard head spaces into waste storage tank compartments, NAVSHIPS authorized a Project TRANSIM simulation investigation of shipboard head facility utilization.

The Head Facilities Model was developed for the DLG 31 configuration, and covered all of the processes and actions of the ship's crew, from the

moment of decision to proceed to a head, to the completion of the crew man's use of the facility. Included are walking, water closet and urinal facility usage, and queueing for the facility, if not available upon the crew man's arrival at the head.

The results of the model analysis indicated that approximately 45 percent of the original combined volume of the ship's heads could be utilized as waste storage tank compartments, without significant reduction in service capability available to the ship's crew.

VI. PROJECT NETWORK ANALYSIS

a. Boiler Repair Network

In order to investigate the suitability of Monte Carlo computer simulation to project network analysis, a feasibility investigation was conducted on a naval shipwork project.

The specific project is concerned with a ship boiler repair at Long Beach Naval Shipyard and is represented by an activity network covering some 20 individual tasks.

The general objective of the investigation was to evaluate the difference between probabilistic and deterministic solutions, the latter obtainable through the use of PERT technique.

The results[27] indicate that the probabilistically-derived expected completion time for the boiler repair is 39 days, compared to the PERT-derived value of 35 days. The probabilistic expected value of 39 days is increased to 46 days if the PERT-derived "floats" are used and the project activities started on their "latest allowable" start dates.

The optimism of the PERT-derived project schedule results from the inability of the deterministic technique to account for the "merger bias" occurring at certain network nodes. The bias can only be accounted for by a probabilistic network analysis technique that accounts for task performance variability.

The results support the conclusion by other investigators, regarding the inherent optimism of deterministic network analysis.

b. TRAM AN/SQS-23

A second investigative project was undertaken to investigate the inherent optimism of deterministic activity network analysis techniques. The analysis

was concerned with a TRAM destroyer alternation project at Boston Naval Shipyard involving AN/SQS-23 sonar. The results in this case indicated that the deterministic completion time for the project is 90 days, or 31 percent below the equivalent probabilistic value of 118 days.

c. <u>ASROC Launcher Exchange</u>

In a typical shipyard there are practical limitations in the availability of resources and shipyard management is continually faced with the tradeoffs between satisfying resource requirements of many projects in order to maintain project schedules while obtaining maximum utilization of a leveled manpower force and other yard resources.

Accordingly, probabilistic analysis of a project activity network was next extended beyond mere scheduling application to include resource requirements analysis and resource leveling. The specific application was the ASROC Launcher Exchange project at Long Beach Naval Shipyard.

The specific objective of the investigation was to demonstrate use of the network simulator for resource-leveling purposes. Some 45 different yard resources were included in the analysis. The results[31] demonstrated the effectiveness of the probabilistic technique in shipyard resource leveling.

VII. PROJECT RISK MANAGEMENT

Scheduling, resource allocation, and project control for ship design, construction, procurement, and associated support functions represent critical problem areas facing Navy management. The uncertainties of normal ship acquisition activities are compounded by the uncertainties related to the procurement and delivery of sub-system components and by design changes, availability of resources, budget availability, and more.

The project manager constantly has the need to make decisions in the face of uncertainty. Hence the probabilistic network technique has considerable advantage as a project management tool.

More important, however, is the realization that if probabilistic network analysis is to be successfully applied, it must be part of a total project management system, including the proper project management organization, personnel, information flow, management reports, and the like.

Having demonstrated the analytical power of the general-purpose TRANSIM simulator in probabilistic analysis of project network models, UCLA then formulated a total Project Risk Management "system" applicable to the entire ship acquisition project management process. Since late 1970, Project Risk Management has been successfully applied to the individual projects listed below.

a. Spanish Ship Project

The initial application of the Project Risk Management technique was in connection with the Spanish Destroyer Project. The Master Material Erection Schedule (MMES) for the DE 1052 was used as a guide to sub-system configuration, and a representative sample of 26 individual sub-systems was selected to be "tracked" within the project activity network.

Based on the results,[33] it was concluded that the Project Risk Management technique is highly suitable for the purposes of ship acquisition project planning, scheduling, resource allocation, and project control.

b. DD 963

The DD 963 contract award for construction of a number of vessels had already been made at the time of application of Project Risk Management by the Ship Acquisition Project Manager (SHAPM). The SHAPM's use of the technique consists of evaluating the contractor's periodic project status report submittals, which are uniformly deterministic.

Using the probabilistic Project Risk Management technique allows the SHAPM to assess the impact of the uncertainties facing the project and accordingly, alert the contractor.

c. ULMS/TRIDENT

Similar to the case of the DD 963 (above), the ULMS/TRIDENT project was well underway at the time of applying the Project Risk Management technique. At the time of application, the SHAPM was interested in assessing the likelihoods of attaining the individual project milestone dates.

d. Patrol Frigate (PF)

The PF project is the first NAVSHIPS full application of the Project Risk Management technique at the SHAPM level. The application was initiated sufficiently early in the ship project to allow setting up of the full system, including information flow and management reporting.

The PF project experience has directly benefitted the UCLA development program in providing feedback based on full application of the technique.

e. AEGIS (DG)

A recent addition to the list of ship acquisition projects using Project Risk Management, the DG Project is at a sufficiently early state to fully use

the technique. It is anticipated that this application will include full use of the cost reporting capabilities of the technique.

f. PERA (CV)

The PERA (CV) activity (Puget Sound Naval Shipyard) applied the Project Risk Management technique to the preplanning and planning of aircraft carriers. The initial application was in connection with the overhaul of the U.S.S. John F. Kennedy.[41] Later, the technique was used for manpower planning and scheduling for a 21-ship project program.

g. NAVFAC Projects

The Project Risk Management technique was adopted by the Naval Facilities and Engineering Command (NAVFAC), Western Division, in connection with management of its projects. At this point, the technique has already been applied to the following projects:

Port Hueneme Hospital and Clinic

Travis AFB Hospital

San Diego Naval Hospital

h. NAVELEX Project

In connection with the new Combat Systems School, Naval Electronics Command (NAVELEX), Western Division, Mare Island Naval Shipyard has adopted the Project Risk Management technique for the purposes of project planning, scheduling and control. The Combat Systems School project is one of major complexity involving, in addition to the station and the school administration, involvement with almost all of the Navy Commands. Hence, the major project management emphasis has been on establishing a responsive project organization and supporting information flow system.

VIII. EVALUATION

A review of the components of the Project TRANSIM ten-year program makes it evident that its objectives have been largely attained. The TRANSIM IV general-purpose computer simulator has become widely accepted as a versatile, easy-to-use, efficient, and analytically powerful systems analysis tool.

Different Navy Commands have undergone training and the TRANSIM IV technique has been used for problem-solving on a large number of different problems ranging from transportation and logistics to shipyard operations.

The TRANSIM IV simulator has been installed on the NAVSHIPS computer installations at NSRDS, Carderock, Maryland, and Applied Physics Laboratory, Johns Hopkins University and is currently available to all NAVSHIPS users.

Derivation of the Project Risk Management technique from the basic TRANSIM IV simulator has resulted in a major advance in the Navy's capability to manage large and complex projects ranging from planning, design, and acquisition, to repair, overhaul, and modernization, both on seaborne and shore-based capital items.

The unique collaborative arrangement between the research and development activities of UCLA on one hand, and the application and user feedback efforts of the project management staffs on the specific NAVSHIPS, NAVFAC, and NAVELEX projects, has resulted in an advanced management technique which, although general-purpose, is nevertheless highly customized to the needs of the Navy.

IX. FUTURE DIRECTIONS

The accomplishments of the past ten year period have graphically demonstrated the potential of the simulator as a versatile, powerful management tool. The UCLA development program will continue to investigate further uses and software derivations and as well, continue to investigate further uses and software derivations and as well, continue to assist the Navy's implementation of the techniques through workshops, documentation and support. Accordingly, the UCLA project has embarked on the next phase of its research and development program with the following general objectives:

a. TRANSIM

Although the TRANSIM IV is the most advanced user-oriented computer simulator currently available in the field, there remains considerable apportunity to further improve the technique toward ultimate simplicity and ease-of-use.

The end objective calls for a computer simulation technique that is competitive with other available Monte Carlo simulation approaches in terms of versatility and analytical power and efficiency, but is user-oriented to the following degree:

1. No familiarity with computer programming and equipment technology need be required for problem set-up and solution.
2. Simulation preparation and set-up to be free from tedious and detailed manual data handling.
3. Input information, descriptions and data to be in terms of the operational conversation language of the user's field.
4. Output formats and reports to be as far as practicable, customized to the user's needs, and in the user's language.
5. Maximum utilization of graphical presentations of output data.

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6. Convenient nomographic or similar means of determining proper statistical parameters for a simulation run, including sample size, length of run, start-up transient, and validation considerations.

b. Project Risk Management

During FY 1975 and beyond, the Project Risk Management technique will be further improved to encompass a full capability for use in cost-estimating, cash flow and budget control. Several additional management reports will be developed together with additional graphical presentations.

Application to NAVSHIPS problem areas will be extended to inlcude shipyard planning and production. The initial step in this direction has been accomplished by application of Project Risk Management to the overhaul and modernization of combat support ships through PERA (CSS), at Hunter's Point Naval Shipyard.

For NAVFAC projects, Project Risk Management will be extended in both hospital and other facility areas. In the case of hospital projects, developments in project management organization and policy will include integration of detailed planning by NAVFAC, Bureau of Medicine, and the station into a single project plan to be implemented under control of a single project organization, in a manner similar to the SHAPM concept, in NAVSHIPS - perhaps a "FAPM" (Facilities Acquisition Project Manager).

The current NAVELEX Combat Systems School experience points to another example of the need for a more in-depth staffing of a project management organization similar to the NAVSHIPS SHAPM concept.

c. Risk Analysis

The UCLA FY 75 program calls for extending the simulator's capabilities into risk analysis, covering the general problem area of decision-making under uncertainty.

X. SUMMARY

The ten-year UCLA research and development program on advanced, general-purpose computer simulation has demonstrated the versatility and analytical power and efficiency of the technique and in particular, its suitability to a wide range of Navy management problem-solving situations.

The TRANSIM family of simulators, and the derived Project Risk Management technique have been successfully used and the latter has, in current applications, demonstrated considerable promise as a technique for minimizing and controlling the schedule and budget risks normally associated with large capital projects.

APPENDIX A
PUBLICATIONS

School of Engineering and Applied Science Reports

1. "An Engineering Analysis of Cargo Handling," Staff Report 53-21, August 1953, 83 p.

2. "An Engineering Analysis of Cargo Handling-II, The Field Study of 1953," Staff Report 55-2, November 1954, 62 p.

3. "An Engineering Analysis of Cargo Handling-III, Analysis of Stochastic Models of Cargo Handling," H. Davis and J. K. Weinstock, Report 56-34, July 1956, 28 p.

4. "An Engineering Analysis of Cargo Handling-VI, Containerization." Joseph D. Carrabino, Report 57-56, July 1956, 188 p.

5. "An Engineering Analysis of Cargo Handling-V, Simulation of Cargo Handling Systems," Russell R. O'Neill, Report 56-37, September 1956, 147 p.

6. "Technical Studies in Cargo Handling-I, Formulation of Recurrence Equations for Shuttle Process and Assembly Line," Richard Bellman, Report 56-53, November 1956, 21 p.

7. "Technical Studies in Cargo Handling-III, Distribution of Delay in the Three Stage Shuttle Process," Yoichiro Fukuda, Report 57-6, February 1957, 21 p.

8. "Technical Studies in Cargo Handling-II, Computation of Delays in the Multistage Shuttle Process," Richard Bellman, Yoichiro Fukuda, Maurice Pollack, Report 57-13, April 1957, 35 p.

9. "Technical Studies in Cargo Handling-IV, Methods of Computing Delays in a N-Stage Shuttle Process." Maurice Pollack, Report 57-37, May 1957, 21 p.

10. "An Engineering Analysis of Cargo Handling-VII, Some Studies on Shuttle and Assembly Line Processes," Maurice Pollack, Report 58-12, February 1958, 42 p.

11. "Systems Approach to Effective Documentation," Louis A. Selogie, Report 58-4, February 1958, 33 p.

12. "Technical Studies in Cargo Handling-V, The Effect of Communication on a N-Stage Shuttle Process," Maurice Pollack, Report 58-43, May 1958, 20 p.

13. "Technical Studies in Cargo Handling-VI, Bibliography of Human Energy Expenditure Literature," Frank C. Hale, Report 58-68, October 1958, 108 p.

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14. "An Engineering Analysis of Cargo Handling-X, Energy Expenditure of Longshoremen," Frank C. Hale and John J. O'Hara, Report 59-20, June 1959, 49 p.

15. "Technical Studies in Cargo Handling-VII, The Human Output Function, Its Concept and Measurement," Project Staff, Report 59-75, December 1959, 20 p.

16. "An Engineering Analysis of Cargo Handling-IX, Allocation of Containers in a Trade Route," F. Cesar Toscano, Report 60-110, December 1960, 35 p.

17. "An Engineering Analysis of Cargo Handling-XI, A Deterministic Mathematical Model for a Two-link, One-node System," Neal A. Richardson, Report 61-35, June 1961, 69 p.

18. "An Engineering Analysis of Cargo Handling-XII, Physiological Measurements in the Evaluation of Work Method Changes," Frank C. Hale, Report 61-75, November 1961, 25 p.

19. "An Engineering Analysis of Cargo Handling-VIII: Information-Communication Network; Documentation Simplification Integration and Automation," Louis A. Selogie, Report 61-65, December 1961, 196 p.

20. "An Engineering Analysis of Cargo Handling-XIV, Optimum Warehouse Layout." John T. Huffman, Report 62-13, March 1962, 50 p.

21. "Technical Studies in Cargo Handling-VIII, Re-examination of Automated Ships," Raymond L. Erler and Jack K. Weinstock, Report 61-68, April 1962, 11 p.

22. "An Engineering Analysis of Cargo Handling-XIII, A Deterministic Productivity Model of Materials Handling System," Neal A. Richardson, Report 62-24, May 1962, 153 p.

23. "Technical Studies in Cargo Handling-IX, Iron Ore Trade and Ore-Carrier Fleet Requirements, Raymond Erler, Report 63-8, February 1963, 23 p.

24. "Cargo Handling Research, A Ten-Year Progress Report," Staff, Report 63-44, October 1963, 34 p.

25. "Technical Studies in Transportation: Transportation Cost Finding," R. N. Farmer, Report 63-65, December 1963, 47 p.

26. "Simulation Analysis of the Marine Port-Complex," A. M. Feiler, Report 66-12, October 1966,

27. "Case Studies in Computer Simulation, A Comparison PERT vs. TRANSIM Network Analysis," J. A. Momm, Report 67-51, July 1967, 24 p.

28. "Simulation Analysis of Military Ocean Terminal, Bay Area," Staff, Report 68-16, March 1968, 35 p.

29. "Systems Analysis of the Port of Los Angeles, California," A. M. Feiler, Report 69-40, July 1969.

30. "Factors Affecting Retrieval of Task-Time Data from Human Store," L. Bongers, Report 69-50, August 1969, 45 p.

31. "TRANSIM Critical Path and Resource Management Analysis, TRAM Ship Alteration AN/SQS-23," A. M. Feiler, Report 69-2, December 1969.

32. "Systems Analysis of the Port of Long Beach, California," P. D. Josselyn, Report 70-3, January 1970.

33. "Case Studies in Computer Simulation, Systems Analysis of the Management Information System/Computer System Long Beach Naval Shipyard," Staff, Report 7049, March 1970, 25 p. plus 22 p. appendix.

34. "Case Studies in Computer Simulation, TRANSIM Activity Network Analysis of ASROC Launcher Exchange Project," Staff, Report 7057, April 1970, 69 p.

35. "Application of TRANSIM IV to ILS Problems, A feasibility Study and Demonstration," Staff, Report 7058, April 1970, 57 p.

36. "Case Studies in Computer Simulation, TRANSIM Activity Network Analysis of Ship Acquisition Project Management," Staff, Report 7086, September 1970, 70 p.

37. "Obtaining Task Time Data from Human Store and Factors Affecting Retrieval," L. S. Bongers, Report 7111, December 1971, 98 p.

38. "TRANSIM IV General Purpose System Simulator," Staff, Report 7168, December 1971, 200 p.

39. "Development, Operating Procedures, and Capabilities of the NSROC Computer Simulation Model for the First-Generation Seaborne Mobile Logistics System (SMLS)," J. J. Fuller and Paul Hubai, NSRDC Technical Note CMD-33-71, August 1971.

40. "Simulation Analysis of Destroyer Head Facilities," Staff, Report 722, March 1972.

41. "PERA (CV) Project Risk Management," A. M. Feiler and G. Jurges, UCLA-ENG-7445, May 1974 (in publication).

42. TRANSIM User's Manual, Staff Report 66-6, May 1966.

APPENDIX B

PRESENTATIONS

Presentations by A. M. Feiler

"Analytical Models for Optimizing Maritime Cargo Handling Systems," A. M. Feiler, R. V. Andrews, presented at Annual Joint Meeting of the Northern and Southern California Sections of the Society of Naval Architects and Marine Engineers, Monterey, California — October 12, 1963

"The Maritime Port Simulation - A Tool for Problem Solving," Maritime Cargo Symposium, MARAD, Port of Los Angeles, Port of Long Beach, UCLA Long Beach — September 17, 1964

"Review and Development of Transportational Functional Simulation Model," DOC Transportation Research Seminar, Washington, D. C. — March 17, 1965

"General Purpose Transportation Simulator: TRANSIM," Annual Meeting, Data Division, Association of American Railroads, St. Louis, Missouri — September 20-29, 1965

"A View of the Marine Port as an Integrated System," presented at a meeting of the Waterways and Harbor Group, Southern California Section, American Society of Civil Engineers, Long Beach, California — February 9, 1966

"TRANSIM - A General Purpose Transportation Simulator," Railway System and Management Association Simulation Symposium, Chicago, Illinois — March 4, 1966

"Terminal Movement Simulation," College of Logistics Symposium on Transportation Decision-Making, Institute of Management Sciences and the Transportation Forum, Washington, D. C. — April 1, 1966

"Simulation Analysis of Physical Distribution Problems," Annual Meeting, California Manufacturer's Association, San Diego, California — August 4, 1966

"General Purpose Transportation Simulator," Transportation Research Forum, Washington, D. C. — June 23, 1966

"Application of TRANSIM to Solution of Logistics Problems," Special Assistant to Joint Chief for Strategic Mobility (SASM) Washington, D. C. — August 17-18, 1966

"General Purpose Computer Simulation," Operations Research Seminar, U.S. Naval Postgraduate School, Monterey, California — January 12, 1967

"Computer Simulation - A Tool for Winery Management," Wine Institute Annual Meeting, Fresno, California — March 17, 1967

"Computer Simulation - A Tool for Hospital Management," Executive Committee Meeting, Hospital Council of Northern California, San Francisco, California — January 8, 1968

"Application of General-Purpose Simulation to the Navy Problems, Research and Technology Conference on Optimization/Statistics Simulation and Information Processing, Office of Naval Research, Washington, D. C. — September 13, 1969

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"Simulation Analysis of Penn Central's New York to Washington Operations," AIIE, Annual Transportation Meeting, Washington, D. C. March 7, 1969

Chairman, Transportation Systems Session, Third Conference on Applications of Simulation, AIIE, ACM, IEEE, SHARE, SCI, TIMS, Los Angeles, California December 9, 1969

Chairman, Transportation Session, 11th American Meeting, TIMS, Los Angeles, California October 19-21, 1970

"Modeling the Transportation and Distribution System," AIIE 3rd National Conference, Pittsburgh, Pennsylvania January 27, 1971

"A New Project Management Tool," Project Management Workshop, USN, Washington, D. C. January 25-27, 1971

"Transportation Problem Solving with Computer Simulation Models," Conference on Transportation Planning and Scheduling, Arlington, Virginia March 17-19, 1971

"Tradeoffs Among Simulation Approaches," Symposium on Computer Simulation as Related to Manpower and Personnel Planning, USN, Annapolis April 27-29, 1971

"A New Management Tool for Ship Projects," American Society of Naval Engineers, Golden Gate Section, Treasure Island October 5, 1971

"Project Risk Management," Management Seminar at Hunter's Point Naval Shipyard, San Francisco, California October 5, 1971

"Computer Modeling of Port Systems," UN Conference on Trade and Development, Geneva, Switzerland June 5, 1972

"Project Risk Management," Seminar at Hunter"s Point Naval Shipyard, San Francisco August 17, 1972

"Application of Computer Modeling to Traffic Circulation and Parking Problems," Beverly Hills Municipal League January 22, 1973

"General-Purpose Simulation - A Panacea?" Engineering Systems Division Seminar, UCLA April 4, 1973

"Project Risk Management," Management Seminar at Naval Facilities Engineering Command, Western Division, San Bruno, California April 12, 1973

"Project Risk Management," Management Seminar Mare Island Naval Shipyard, Vallejo September 12, 1973

"Project Risk Management II," Management Seminar, Mare Island Naval Shipyard, Vallejo, California November 15, 1973

"Comprehensive Transportation Planning for City of Los Angeles," Public Utilities and Transportation Commission, Los Angeles December 13, 1973

"Project Risk Management III," Management Seminar, Mare Island Naval Shipyard, Vallejo, California December 27, 1973

Other Presentations

A. M. Feiler E. O. Fisher	"Computer Simulation Analysis of Intermodal Transportation," NATO Conference, Sandefjord, Norway	August 14, 1972
D. McMichael B. Orleans	"TRANSIM - A General Purpose Problem Solving Tool," American Society of Naval Engineers, Annual Meeting, Washington, D. C.	February 1, 1973
G. Jurges	"Risk Management Keeps Aircraft Carrier Overhaul Planning on Schedule," American Society of Naval Engineers, Annual Meeting, Washington, D. C.	February 1, 1973

APPENDIX C
SIMULATION WORKSHOPS AND COURSES

Workshops

Wine Institute (STSP)	Fresno, Calif.	May 1967
Calif. Trucking Assoc. (STSP)	Fresno, Calif.	June 1968
	Burlingame, Calif.	April 1968
	Los Angeles, Calif.	June 1968
Hospital Council of Northern and Southern California (STSP)	San Francisco, Calif.	June 1968
	Los Angeles, Calif.	December 1968
	Los Angeles, Calif.	March 1968
Ports/Port Industry Management (STSP)	San Pedro, Calif.	October 1968
Physical Distribution Management (STSP)	San Francisco, Calif.	February 1969
NAVSHIPS	Washington, D. C.	February 11-12, 1969
		April 22-23, 1969
		July 15-16, 1969
NPGS	Monterey, Calif.	May 9-10, 1969
		May 19-20, 1969
LBNSY	Long Beach, Calif.	May 26, 1969
		October 17, 1969
		November 12, 1969
COMNAVSHIPS	Washington, D. C.	July 14, 1969
NAVSEC	Washington, D. C.	September 15-17, 1969
NAVSEC and NAVSHIPS	Washington, D. C.	1973

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Courses

Engineering Executive Program:

470B April 13, 1973
470C May 25, 1971; May 8, 1972; May 27, 1972
470D October 10, 1966; October 31, 1967; November 4, 1968; October 21, October 28, November 4, 1969; November 2, 1970; May 25, 1971

Architecture and Urban Planning:

238 Research in ARchitectural and Urban Analysis February 9, 1973
238A Health Care Dacilities Planning November 2, 1973

Extension Courses:

X461POR Product Development October 1967, November 1968
X407.1 Construction Manaement February 14, March 8, 1973

Short Courses:

847.2 Warehousing - Plant Layout and Mareria1 Handling, September 13-17, 1971; September 10-14, 1973